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USDA Forest Service

Rocky Mountain Forest and  
Range Experiment Station

# Constructing Wooden Boxes for Cavity-Nesting Birds

Howard L. Gary and Meredith J. Morris<sup>1</sup>

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Construction details for two sizes of nest boxes are described. In field trials, eight species of cavity-nesting birds nested in the smaller boxes and five species, in addition to red squirrels, raised young in the larger nest boxes.

**Keywords:** cavity-nesting birds, nest boxes, birdhouses

## Management Implications

Nest boxes will never replace natural cavities found in live trees and snags. However, when few or no trees with natural cavities are available, nest boxes can help meet cavity requirements and help maintain diversity and populations of cavity-nesting birds.

## Introduction

The scarcity of nesting and roosting cavities is a major factor limiting the populations and diversity of primary cavity-nesting birds (woodpeckers) and secondary cavity-nesting birds (those using old woodpecker holes).<sup>2</sup> An average of two or three nesting trees per acre is needed to maintain diversity and populations of secondary cavity-nesting birds in southwestern ponderosa pine (*Pinus ponderosa*) forests (Balda 1975, Scott 1978) (fig. 1). Past commercial timber harvesting practices and increasing demand for fuelwood in national forests of the central Rocky Mountains, especially along the Front Range in Colorado, have reduced the number of nesting trees (American Forests 1979).

When nesting trees are scarce, nest boxes can supplement or substitute for natural nest cavities. Studies by Hamerstrom et al. (1973) with American kestrels (*Falco sparverius*), and Zeleny (1973) with eastern bluebirds (*Sialia sialis*) demonstrated an increase in

breeding when suitable boxes were provided. Bruns (1960) and Franz (1961) cite several European works that document a fivefold to tenfold increase of insectivorous cavity-nesting birds after nest boxes were introduced.

This note describes construction of two sizes of wooden nest boxes and their use by birds and mammals in Colorado Front Range ponderosa pine forests. Design of the boxes was adapted from various features of existing box plans (Sawyer 1955, Peterson 1963, U.S. Department of Interior 1969, and Zeleny 1977) (table 1).

## Nest Box Design and Placement

Entry hole sizes shown in table 1 restrict use to selected species or similar-sized birds. Starlings (*Sturnus vulgaris*), for example, cannot enter boxes with holes smaller than 1-1/2 inch in diameter. Entry holes 3 inches in diameter are recommended for common flickers (*Colaptes auratus*), for example, but this size hole does not prevent use by smaller species, such as mountain bluebirds (*Sialia currucoides*).

Nest boxes should be placed on posts or trees and secured with nails or wire. Boxes generally should face the nearest trees, shrubs, fences, etc., so that birds on their first flight may reach a perch high enough to provide protection against predators. Boxes in trees should be in the more open areas within the crown so birds can easily find them.

<sup>1</sup>Principal Hydrologist and Principal Wildlife Biologist, respectively, Rocky Mountain Forest and Range Experiment Station. Central headquarters is at Fort Collins, in cooperation with Colorado State University.

<sup>2</sup>Beebe, Spencer B. 1974. Relationships between insectivorous hole-nesting birds and forest management. Unpublished manuscript, 49 p. Yale University, School of Forestry and Environmental Studies, New Haven, Conn.

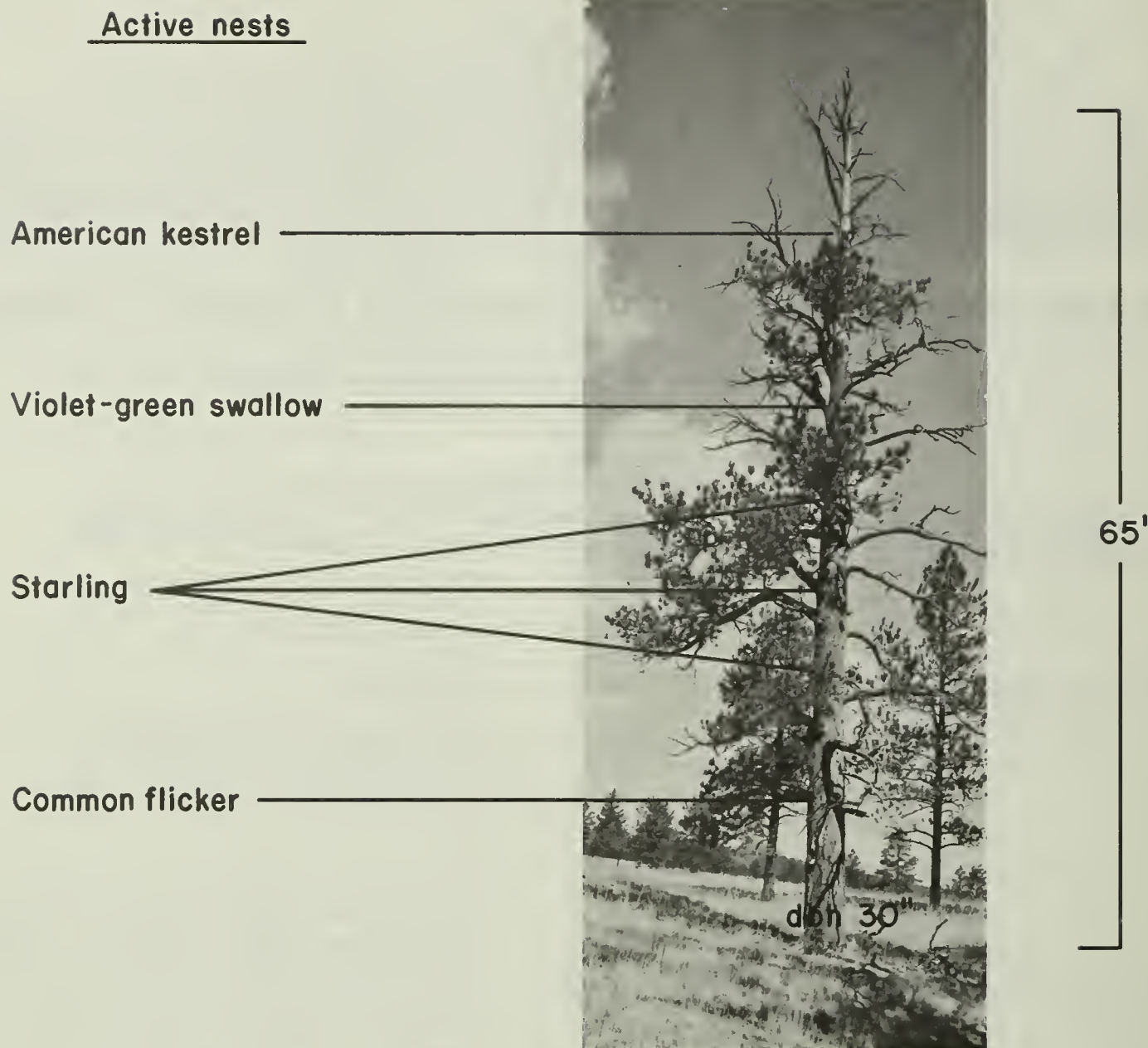


Figure 1.—High quality nesting trees are rapidly disappearing from accessible areas along the Front Range in Colorado.

Boxes to accommodate western bluebirds (*Sialia mexicana*) should be placed along forest edges or in grassy glades within open forests. Kestrels prefer to nest in open areas because of their hunting habits. Boxes should be accessible from the ground or by ladder to allow inspection, cleaning, and minor repairs.

Nesting material should not be provided in the small-floor-size box (table 1) since most species using these boxes build their own nests. The large-floor-size nest box (table 1), intended for larger species which do not build nests, should have 1/2 to 1 inch of wood shavings. Old nests should be removed and boxes cleaned each fall to reduce fouling and parasites.

Two to four small nest boxes per acre are recommended. This density will prevent most intraspecies and interspecies conflicts for territorial right (Sawyer 1955). One large nest box per 10 acres is recommended if the objective is to attract the larger, less common birds, such as American kestrel, flammulated owls (*Otus flammeolus*), and saw-whet owls (*Aegolius acadicus*). These species are

generally less affected by removal of nesting trees (Balda 1975).

Some nest boxes are never used by resident birds, perhaps because plentiful natural nesting sites are available elsewhere, boxes are not found, entrance holes are too small, boxes are placed too high or low, predators are present, or construction is faulty. However, western and mountain bluebirds were found to accept large nest boxes with 3-inch entry holes at locations 20 feet above ground when there were no other nesting sites. Kind, size, and placement of nest boxes should be based on nest requirements of specific species. A nest box not used its first season may be used the next year.

#### Nest Box Construction

Two nest boxes, designated small and large, were designed as acceptable, durable, and relatively inexpensive substitutes for natural cavities.

Table 1.—Dimensions (inches) and placement of nest boxes acceptable by selected cavity-nesting birds in the Front Range in Colorado (adapted from Sawyer 1955, Peterson 1963, and U.S. Department of the Interior 1969)

Species	Floor size	Box depth	Entry hole diameter	Feet above ground
Mountain chickadee ( <i>Parus gambeli</i> )	<sup>1</sup> 4x5-1/2	6 to 8	1-1/8	5 to 10
House wren ( <i>Troglodytes aedon</i> )	"	"	1-1/4	"
Violet-green swallow ( <i>Tachycineta thalassina</i> )	"	"	1-1/2	"
Tree swallow ( <i>Iridoprocne bicolor</i> )	"	"	"	"
Downy woodpecker ( <i>Dendrocopos pubescens</i> )	"	8 to 10	1-1/4	"
Pygmy nuthatch ( <i>Sitta pygmaea</i> )	"	"	"	"
Red-breasted nuthatch ( <i>Sitta canadensis</i> )	"	"	"	"
White-breasted nuthatch ( <i>Sitta carolinensis</i> )	"	"	1-1/2	"
Western bluebird ( <i>Sialia mexicana</i> )	"	"	"	"
Mountain bluebird ( <i>Sialia currucoides</i> )	"	"	"	"
Hairy woodpecker ( <i>Dendrocopos villosus</i> )	<sup>2</sup> 6x7-1/2	12 to 16	"	10 to 25
Saw-whet owl ( <i>Aegolius acadicus</i> )	"	"	2-1/2	"
Common flicker ( <i>Colaptes auratus</i> )	"	"	3	"
American kestrel ( <i>Falco sparverius</i> )	"	"	"	"
Common screech owl ( <i>Otus asio</i> )	"	"	"	"

<sup>1</sup>Standard 1- by 6-inch boards for floor and walls, actual size variable from board to board.

<sup>2</sup>Standard 1- by 8-inch boards for floor and walls, actual size variable from board to board.

Both boxes can be constructed from 1-inch redwood or pine. Lumber grades no. 2 and no. 3 planed or rough one side are suitable. Drilled pilot holes for nails are necessary if splitting is a problem. Loose knots and minor splitting can be patched with small blocks of wood or sheet metal. The wood should weather naturally to blend with surrounding vegetation.

Materials and dimensions for the nest box sizes are shown in table 2. Variable board widths are satisfactory if all box components are cut from the same board. Depending on condition of the lumber and expected waste, length of box wall components in table 2 can be shortened 1 inch to fit various standard board lengths. For example, shortened wall, bottom, and lid components for a large nest box can be cut from an 8-foot-long board, or for two small boxes from a 10-foot-long board.

Box components are most easily cut with a table saw (for bevel cuts), radial arm saw (for straight and angle cuts), and a drill press (circle cutter for entry holes.) The 1-1/2- and 3-inch-diameter entry holes are centered 2 and 3 inches below the top of the front wall of the small and large boxes, respectively. An electric hand drill fitted with a high-speed 1-1/2-inch-diameter wood bit or hole cutter may be used to make the small entry hole.

Boxes can be assembled with simple hand tools after components are cut and entry holes made (fig. 2). Assembly of the small box is similar.

A few preconstruction tasks should be completed before assembly. A pencil line is drawn about 4 inches down from one end of the back board (fig. 2A). The line is needed to position the sides at the top of the box. Next, drill 1/8-inch-diameter holes about 1-1/2 inches down and in from the edge on each end of the back board (fig. 2A). A third hole is also drilled between the holes at each end of the back board. These holes are used to attach the box to a tree or fencepost. Two or three vents and/or lighting holes (3/8- to 1/2-inch diameter) should be drilled about 1 inch below the top of both side boards (fig. 2A). The final preconstruction task is to scratch or roughen the inside of the box front with a wood chisel or saw (fig. 2B). The roughened surface serves as an escape ladder for fledglings. A strip of hardware cloth stapled to the inside front serves the same purpose. In the large nest box, a small block of wood (2 by 2 by 2 inches) nailed halfway down on the inside front board will serve as a ladder and inside perch.

Illustrated step-by-step construction is presented in figure 2. First, attach the sides to the back board. Place the long edge of each side, in turn, flush with the pencil line, align with the edge of the back board, and nail using three to five sixpenny box nails (fig. 2A).

The bevel on the box front is then aligned with the slope of the sides (fig. 2C). One nail is set on each side near the top. This makes it possible to apply leverage to align

Table 2. Materials and approximate dimensions of components for small and large nest boxes

Materials	Small box	Large box
- - (inches) - -		
Lumber for box (standard dimension)	1x6x62	1x8x96
Front (length) <sup>1</sup>	10	17
Back (length)	17	24
Sides, cut on diagonal (total length)	20-1/2	34
Long edge	11	18
Short edge	9-1/2	16
Lid <sup>2</sup>	10	13
Bottom <sup>3</sup>	4-1/8	5-7/8
Lumber for lid cleats (1- by 2-inch board)	9	19-1/2
Lid holding cleat (length) <sup>4</sup>	5-1/2	7-1/4
Lid under cleat (length)	3-1/2	5
Lid outside cleat (length)	—	7-1/4
- - Amount - -		
Hardware		
Nails (sixpenny box)	18-20	26-30
Round-head stove bolts, nuts (3/16 inch)		
For lid hinge (1 inch long)	4	4
For lid holding cleat (2 inches long)	2	2
Washers (3/16 inch)	8	8
Loose pin butt hinge (2 inches)	1	1
Screw eyes for latch (3/4 inch)	2	2
Galvanized wire for latch (12 gage)	10 inches	10 inches
Nail for latch (eightpenny box)	1	1
Double-headed nails to secure box on post or tree (sixteenpenny)	4	6

<sup>1</sup>15° bevel edge (suggested) top of front wall. Bore 1-1/2- or 3-inch entry holes for small and large boxes, respectively.

<sup>2</sup>15° bevel edge (suggested) for lid contact against back wall.

<sup>3</sup>Cut to fit inside box walls (exact size dependent on board width). Cut one-fourth-inch triangle from each corner for drainage holes.

<sup>4</sup>15° bevel edge (suggested) for contact with lid.

either side with the front. Three or four additional nails to each side are adequate to secure the box front.

The box bottom should be carefully measured and sawed for a snug fit (fig. 2D). Remove a one-fourth-inch triangle from each corner to allow drainage. Recess the bottom board about one-fourth-inch to prevent weathering and secure, using one or two nails on each side.

The lid is constructed by nailing two 1- by 2-inch cleats (cut to size shown in table 2) to the underside of the lid board (fig. 2E). The cleats minimize warping and splitting and prolong life of the box lid.

The lid-holding cleat is next attached to the box (fig. 2F). With the box lying on its back, position the lid on top of the box with the beveled edge against the back board. The beveled edge of the lid-holding cleat is then placed and held in contact with the lid and back board. Draw a pencil line against the upper edge of the cleat to mark this position. Remove the lid from the box and realign the lid-holding cleat with the pencil line and nail to the back board using small finishing nails or brads. Then drill two 3/16-inch holes 1-1/4 inches from each end of the cleat, and through the back board. Attach the cleat to the back board using 3/16- by 2-inch stove bolts, nuts, and washers, and remove excess length of bolts with a hack-saw or boltcutter.

Many types of latches, fasteners, hinges, posts, pins, screws, etc. can be used to secure lids to nest boxes. A loose-pin butt hinge and wire fastener was used here to secure the removable lid. With the box on its back, position the

lid under the lid-holding cleat and in contact with the box front. A space of about one-sixteenth inch should remain between the lid and box back (shimmed with a nail) to allow easier closing during wet weather. The butt hinge (with pin in place) is then centered above the entry hole and held in contact with the underside of the lid and box front (fig. 2G). Scribe the location of the holes in the hinge half against the box front with a pencil or awl. Scribe the position of two holes in the upper hinge half after attaching the bottom half of the hinge. Drill 3/16-inch holes at the scribed locations and attach the hinge using 3/16- by 1-inch stove bolts, nuts, and washers (fig. 2G). Remove and discard the loose pin holding the hinge halves together. Slight adjustments can be made by repositioning one side of the hinge if the hinge halves do not mesh smoothly. A metal cutting file may also be used to improve the mesh of the hinge halves.

The nest box lid is secured with a wire pin inserted through the hinge halves. The pin device is shown in figures 2H and I. The fastener is made from a straightened, 10-inch piece of 12-gage galvanized wire shaped and bent to an approximate right angle with about 3-1/2 inches on the side and a one-half inch square eye on one end. Two pairs of heavy-duty pliers for bending the wire and a wire cutter to remove excess wire are the only tools needed to make the fastener. A hammer and a hard metal surface may also be used to further straighten the finished fastener. Extra standard size fasteners should be made to replace any that are lost.

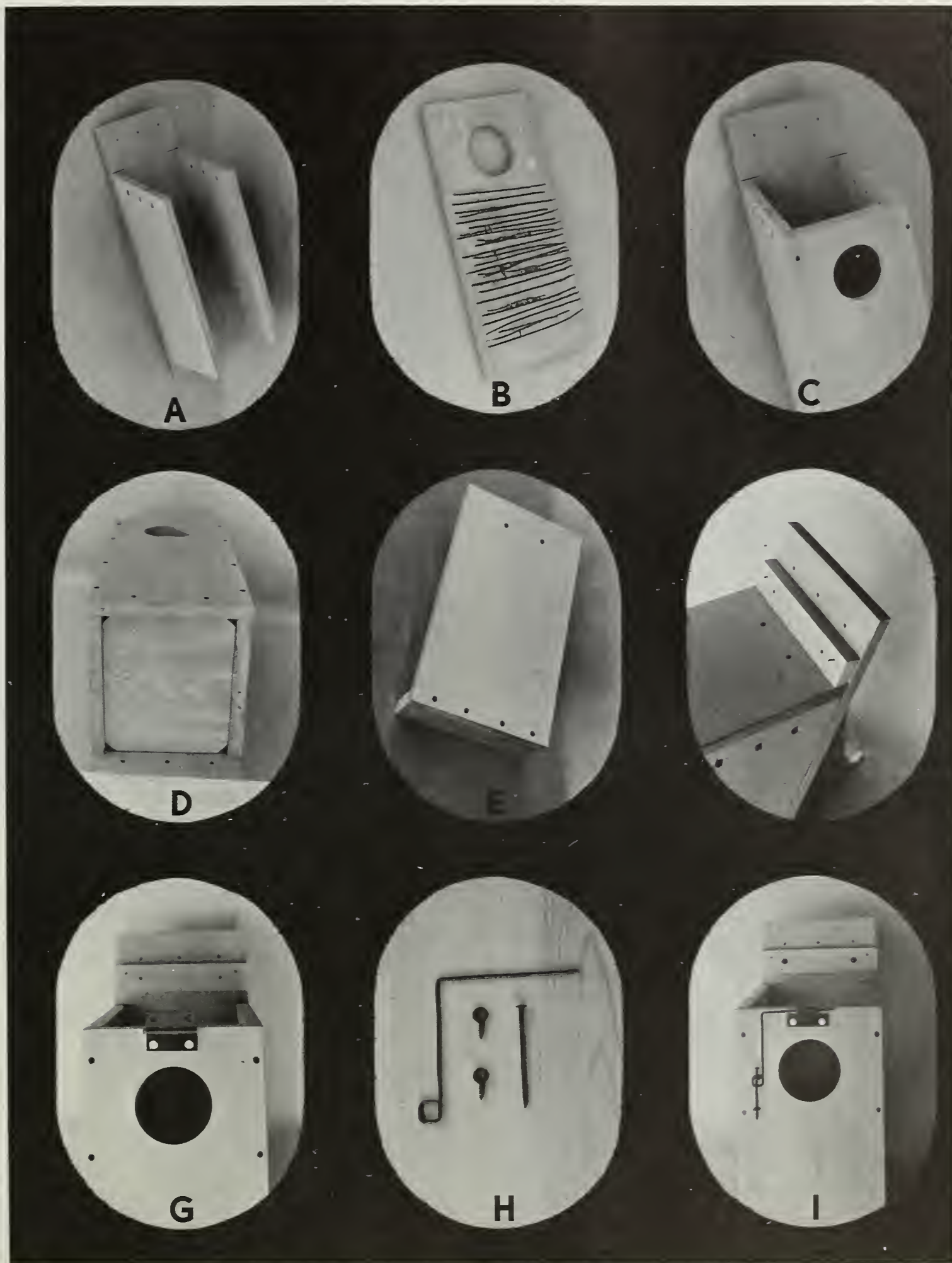


Figure 2.—Construction details for the large nest box.

With the fastener in place, either left or right side of the hinge, set the first screw eye about 1 inch from the edge of the front wall in the center of the square eye. Set the second screw eye about 1-1/2 inches directly below the first. Position both screw eyes horizontally. Insert an eight-penny box nail from the top through the screw eyes to provide a lock for the fastener. Finished models of the small and large nest boxes are shown in figure 3.

#### Use of Nest Boxes

Nest boxes placed in large open areas within the Colorado Front Range ponderosa pine forests most commonly attract western and mountain bluebirds (fig. 4). In a recently logged ponderosa pine stand with few natural cavities on the Manitou Experimental Forest about 30 miles northwest of Colorado Springs, Colo., 100 small nest boxes were placed 5 feet above ground at densities ranging from two to six boxes per acre. These nest boxes, made for bluebirds, were similar in dimensions to the small box, but had lids secured with



Figure 4.—Small nest boxes in open ponderosa pine forests are commonly accepted by bluebirds.

screws. Box lids attached with loose-pin butt hinge and wire pin closures described in this note are much faster to remove and longer lasting than screw lid equipped boxes. During a 2-year period, the 100 boxes were used by 103 breeding pairs of cavity nesters.<sup>3</sup> The following birds fledged young:

Species	Breeding pairs fledging young	
	Number	Percent
Western bluebird	70	68.0
Mountain bluebird	12	11.6
House wren	10	9.7
Violet-green swallow	4	3.9
White-breasted nuthatch	3	2.9
Mountain chickadee	2	1.9
Pygmy nuthatch	1	1.0
Tree swallow	1	1.0
Total	103	100.0

<sup>3</sup>Unpublished data on file, Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo.

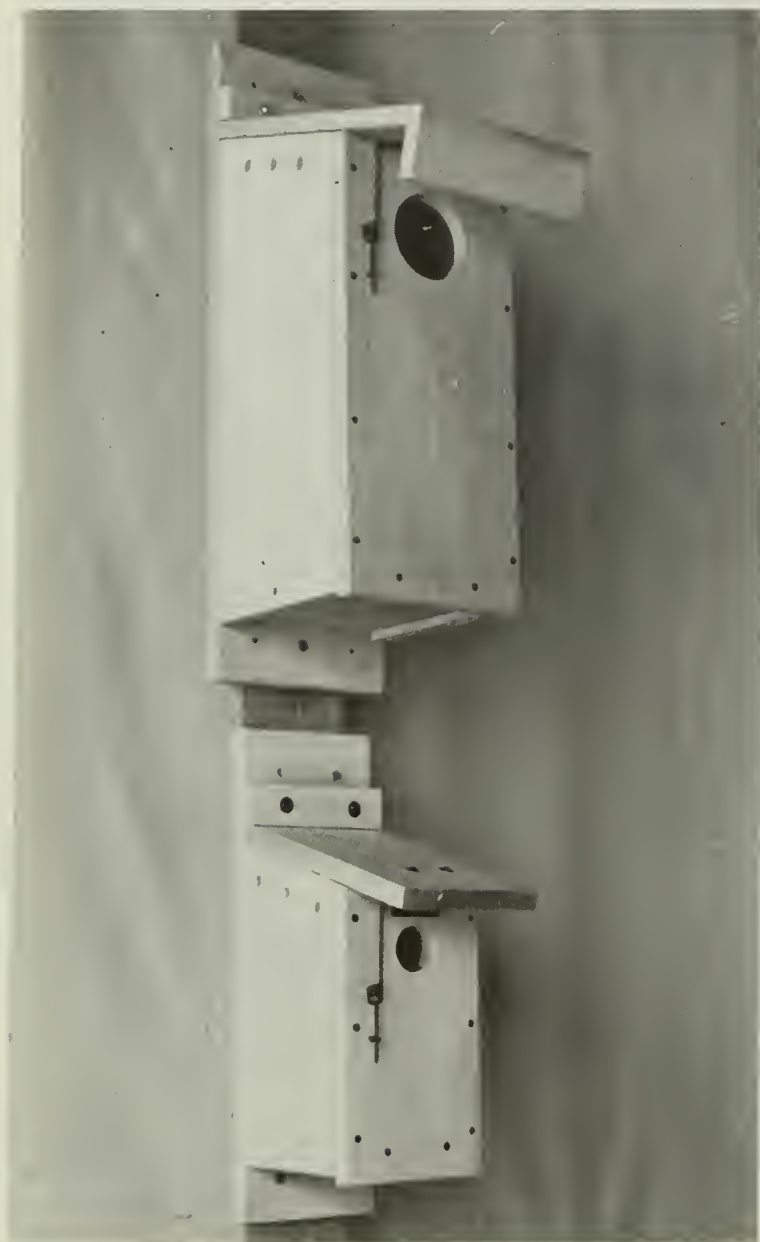


Figure 3.—Completed models of the small and large nest boxes.

Five small boxes constructed as described in this note were placed at the same height, density range, and in the same area as the 100 boxes. The first year these boxes were used by two pairs of western bluebirds and one pair each of mountain bluebird, violet-green swallow, and white-breasted nuthatch.

Thirty of the large nest boxes with 3-inch entry holes placed 20 feet above ground and greater than one-fourth mile apart in open to dense old-growth ponderosa pine and mixed conifer forests with some natural cavities have been used by western and mountain bluebirds, tree swallows, common flickers, American kestrels, and red squirrels (*Tamiasciurus hudsonicus*) (fig. 5).

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Figure 5.—An American kestrel feeding young in a large nest box.

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## Rocky Mountain Forest and Range Experiment Station

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